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INTERFACE DEVICE BETWEEN TESTING EQUIPMENT AND INTEGRATED CIRCUIT

The invention relates to an interface device for providing an interface between testing equipment and an integrated circuit to be tested using the testing equipment.

A probe card is used in semiconductor wafer fabrication and/or packaging facilities to test the integrity of every semiconductor chip produced. The process of testing involves testing equipment referred to as "probers" and an interface device which couples the testing equipment to the semiconductor chip to be tested. The interface device is commonly known as a "probe card". The probe card generally comprises a large number of probes, which take the form of pins and which are arranged on a printed circuit board or other supporting structure, in a pattern which is specific to the semiconductor chip to be tested.

Test signals are exchanged between the prober and the semiconductor chip via the probe card and in particular, the probes which contact the bond pads on the semiconductor chip to be tested. The quality of signals received by the prober from the chip is dependent on the quality of the probe card and the quality of contact between the probes and the bond pads on the chips.

Conventional probe cards incorporate a pin geometry in which the main body of the pin approaches the bond pads on the dye

at an angle of approximately 7° to 20° from the horizontal, with the contacting tip of the probe angled relative to the main body of the pin at an angle of typically 103° to 108° to contact the bond pad of the dye. Hence, the force of contact between the pin and the bond pad is dependent on the section modulus of the probe pin. The contact force that can be applied to the bond pad reduces as the length of the pin increases. Hence, conventional probe card designs have a disadvantage that the more pads which exist towards the center of the dye or the needle array, the more difficult it is to exert the required force between the end of the pin and the bond pad to perform the electrical tests accurately, which is the primary cause of yield loss at the wafer sort stage.

This is a particular problem with new integrated circuits which are becoming denser and include structures which are smaller in size which makes the use of multi die probing inevitable. Due to this, conventional probe card design is becoming more complicated and difficult to manufacture which makes the probe cards more expensive to manufacture and to maintain a balanced contact force on all the bond pads simultaneously.

In accordance with the present invention, an interface device for providing an interface between testing equipment and an integrated circuit to be tested comprises a body member, a movable member mounted on the body member for movement with

respect to the body member and a number of elongate contact members vertical probes mounted on the movable member, for movement with the movable member; each elongate contact member comprising a contact end, adapted to contact a bond pad of an integrated circuit to be tested, and a body portion, the central axis of the body portion and the contact end being substantially parallel to each other.

The advantage of the invention is that, as the contact end is substantially parallel to the body portion of the contact member, it is possible to obtain better contact between the contact member and a bond pad on a chip to be tested.

Preferably, each contact member comprises a spring shaped portion located between the probe end and the body portion. Typically, the spring shaped portion comprises two portions at an angle to each other and to the body portion and the contact end. Preferably, one of the spring portions is longer than the other spring portion so that the central axis of the contact end is not coincident with the central axis of the body portion. Preferably, the spring portion coupled to the contact end is longer than the spring portion coupled to the body portion to permit immediately adjacent contact members to have their contact ends in line with each other and the body portions offset from each other. In other words, the contacting end and the vertical spring shaped body member are offset in the vertical axis. This feature has the advantage of permitting the contact members to be located

closer to each other while minimising the risk of the body portions contacting each other.

Preferably, the contact ends and the spring portions attached to the contact end are tapered towards the end of the contact end. This minimises the risk of the contact ends contacting each other in use.

Preferably, the interface device further comprises a printed circuit board to which the ends of the contact members opposite to the contact ends are coupled and the printed circuit board is adapted to permit the testing equipment to be coupled to the printed circuit board.

Preferably, the movable member is coupled to the body member by an elastically flexible member. Preferably, the body member, the elastically flexible member and the movable member are fabricated from a single piece of material, portions of the material being removed to form the elastically flexible member. Preferably, the material from which the body portion, elastically flexible member and the movable member is fabricated is a metal, such as steel, aluminium or titanium. Typically, the elastically flexible member may be in the form of an elastic beam which is generally "U" shaped.

Preferably, the movable member is coupled to the body member by a number of elastic flexible members. Typically, where

the body member is generally rectangular, the movable member is located within the body member and may be coupled to the body member by four elastic flexible members. Typically, the movable member defines an aperture at the center into which the contact members protrude. Typically, the aperture may be covered by a covering material through which the contact ends of the contact members protrude. Typically, the cover material may comprise a glass, such as borosilicate glass.

Typically, the interface device may further comprise an excitation device to move the movable member with respect to the body member. For example, the excitation device may be a piezo-electric device, a micro motor or an ultrasonic device. Typically, the movement of the movable member with respect to the body member may be in the order of 10 microns to 100 microns.

Preferably, the elongate contact member may be formed from metal wire with a diameter of 1 mil to 10 mil and is preferably in the region of 4 mil to 10 mil. Typically, the contact surface of the contact ends may have a diameter of approximately 0.5 mil to 5 mils and preferable 1 mil to 2.5 mils. The contact surface may be either planar or curved. Preferably, the contact members may be tungsten, beryllium copper, palladium, paliney or an alloy of two or more of these materials. Preferably, the angle between the spring shaped portions of the contact members is approximately 45^0 to 135^0 and is preferably in the region of 60^0 to 135^0.

Preferably, the central axis of the contact end and the central axis of the body portion are separated by a distance which is approximately equal to 1.5 times the diameter of the body portion.

An example of an interface device in accordance with the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a schematic perspective view of an interface device showing the principle of operation;
Figure 2 is a side view of a portion of a contact pin for use in the interface device;
Figure 3 is a plan view of a body member and a movable member for use with an interface device;
Figure 4 is a side view of the body member and movable member shown in Figure 3;
Figure 5 is a plan view of a jig for forming the contact pin shown in Figure 2;
Figure 6 is a left hand side view of the jig shown in Figure 5;
Figure 7 is a front view of the jig shown in Figure 5;
Figure 8 is a front view of a bend former for use with the jig shown in Figures 5 to 7; and
Figure 9 is a right hand side view of the bend former shown in Figure 8.

Figure 1 shows a schematic view of a probe card 2. The probe

card 2 includes a flexure ring 1, a glass plate 3, a printed circuit board (PCB) 4 and a number of contact pins 5 mounted on a mounting member 6 attached to the flexure ring 1.

The flexure ring 1 comprises a main body member 7, a movable member 8 and an elastic beam 9 interconnecting the main body member 7 and the movable member 8. The elastic beam 9 is generally "U" shaped and is coupled at one end of the "U" shape to the movable member 8 and coupled at the other end of the "U" shape to the main body member 7. The main body member 7 is attached to the PCB 4 and the movable member 8 is attached to the mounting member 6 and the glass plate 3 is attached to the lower end of the movable member 8.

Each of the contact pins 5 comprises an end portion 10 for coupling to the PCB 4 and which rest on the mounting member 6. At the opposite end of the end portion 10 from the PCB 4, a central portion 11 depends from the end portion 10 at approximately right angles to the end portion 10. A bent section 12 depends from the central portion 11 and terminates in a contact end 13. The central portion 11 , bent section 12 and contact end portion 13 are shown in more detail in Figure 2. In Figure 2 it can be seen that the bent section 12 includes a first spring portion 14 and a second spring portion 15. The spring portion 14 depends from the central section 11 and the second spring portion 15 depends from the first spring portion 14. The contact end portion 13 depends from the lower end of the second spring portion 15. As shown

in Figure 2, the length of the second spring portion 15 is longer than length of the first spring portion 14. This generates an offset between the central axis of the end portion 13 and central axis of the central portion 11, which are generally parallel. The offset is typically approximately 1.5 times the diameter of the central portion 11. The angle between the first spring portion 14 and the second spring portion 15 is typically in the region of 45^0 to 135^0 and is preferably between 60^0 and 135^0.

The contact pins 5 are typically manufactured from a metal wire such as tungsten, beryllium copper, palladium, paliney alloy or any other suitable metal material. The contact pins 5 can also be comprised of a suitable base metal with another metal coated on this base metal. The wire diameter is typically in the region of 1 mil to 10 mil and the surface of the contact end 13 may have a diameter of approximately 1 mil to 2.5 mil with a flat or curved surface. In addition, the second spring portion 15 and the contact end 13 are etched to form a taper towards the contact end 13, as shown in Figure 2.

The glass plate 3 is typically a borosilicate glass and has micro holes 16 therein which may be formed by laser drilling, and the contact end 13 protrudes through the micro holes 16.

The movable member 8 is coupled to a driving device (not shown) which vibrates the movable member 8 relative to the

body member 7. Suitable driving devices may be piezo-electric devices, micro motors or ultrasonic devices. Typically, the movement of the movable member 8 generated by the driving device is of the order 10 microns to 100 microns. As both the contact pins 5 and the glass plate 3 are attached to the movable member 8, both the contact pins 5 and the glass plate 3 move with the movement of the movable member 8.

A typical flexure ring 1 arrangement is shown in Figures 3 and 4. The body member 7 extends around the periphery of the flexure ring 1 and the movable member 8 is located within the body member 7 and is connected to the body member 7 only by four elastic beams 9. An aperture 17 is defined by the movable member 8 and the aperture 17 is filled with the glass plate 3. The flexure ring 1 is formed from a single piece of material, such as steel, aluminium or titanium and the elastic beam 9 and the movable member 8 are formed by cutting slots 18, 19, 20, 21 in the material. The configuration of the slots 18 - 21 which define the body member 7, the movable member 8 and the elastic beams 9 are such that the movable member 8 is able to move relative to the body member 7 only in one dimension as indicated by the arrows 22 in Figures 1 and 3. In particular, the movable member 8 is prevented from moving at right angles to the arrows 22 by the configuration of the slots 18 - 21 and the thickness of the material used for the flexure ring 1. As shown in Figures 3 and 4, the flexure ring 1 also includes two mounting plates 23 located at opposite ends of the flexure ring 1 which permit the

flexure ring 1 and in particular, the body member 7 to be attached to the PCB 4 and permits the interface device to be mounted on a suitable support on the testing equipment.

Figures 5 to 7 show a bending jig 30 for forming the contact pins 5. The bending jig 30 includes five parallel slots 31 each of which accommodates a piece of wire from which a contact pin 5 is to be formed. The wires are each placed in one of the slots 31 such that the end of the wire extends across a transverse "V" shaped recess 32 in the jig 30. The "V" shaped recess 32 (see Figure 7) includes a left hand surface 33 and a right hand surface 34. The left hand surface 33 is shorter than the right hand surface 34 and the right hand surface 34 exits at a higher level than the exit of the surface 33 from the "V" shaped recess 32.

A former 35 for use with the jig 30 is shown in Figures 8 and 9. The former 35 has a "V" shaped portion 36 which conforms to the "V" shaped recess 32 and a planar section 37 which lies over surface 38 of former 30 when the "V" shaped portion 36 is inserted into the "V" shaped recess 32. When the jig 35 is abutted against the former 30 such that the "V" shaped portion 36 engages with the "V" shaped recess 32, the "V" shaped portion 36 recess 32 forms the spring shape portion 13 in the contact pin 5.

In use, the interface device 2 is electrically coupled to testing equipment via contacts on the PCB 4 and the glass

plate 3 is placed over a silicon wafer (not shown) which contains a number of dies to be tested. The contact pins 5 are arranged on the dies in a specific pattern such that when the glass plate 3 is placed over a semiconductor wafer, the contact ends 13 contact the bond pads of the dies on the silicon wafer. Actuation of the driving device causes relative movement of the pins 5 against the bond pads of the dies to generate a scrubbing action to brush off any oxide present on the surface of the bond pads to ensure good electrical contact between the bond pads and the prober during testing.

An advantage of the invention is that the central axis of the contact end 13 is parallel to the central portion 11 and the use of the spring section 12 helps maintain a constant contact force on the bond pads when the movable member 8 is driven to cause the contact pins 5 to scrub the bottom pad. In addition, the orientation of the contact pins 5 permits a higher force be more easily exerted on the bond pads, as desired.